is the wind that there outweighs the rainy season in influencing the daily barometric march. At Colon, in the dry season, 97 per cent of the winds are from the Atlantic Ocean, while in the rainy season these are but 22 per cent, and there are 50 per cent from the south, i. e., from the land. Hence the divergence. It is scarcely to be assumed that the small amplitude a_2 (only 0.67 mm.) is due to this circumstance. I regard this small value as improbable.

Finally, the intermediate (mean) ordinates of the daily barometric curve should be mentioned. Here, again, Colon probably has too small amplitudes, while for Alhajuela they probably are too large. But in this case we have 24 hourly observations, while the other three localities have but bihourly observations, whereby the daily march is somewhat flattened. (See Table 9.)

TABLE 9.—*Average ordinates of the curves of the daily march of pressure (maximum).*

	Ancon.	Culebra.	Alhajuela.	Colon.	Means.
January	0.659	0.752	0.748	0.527	0.671
February	0.650	0.777	0.885	0.539	0.713
March	0.639	0.821	0.957	0.547	0.756
April	0.673	0.780	0.772	0.545	0.693
May	0.544	0.597	*0.577*	0.508	0.557
June	0.479	0.624	0.639	0.452	0.548
July	*0.449*	*0.563*	0.621	*0.437*	*0.517*
August	0.547	0.617	0.677	0.498	0.585
September	0.609	0.648	0.754	0.582	0.648
October	0.644	0.638	0.720	0.602	0.651
November	0.652	0.687	0.663	0.533	0.646
December	0.626	0.727	0.748	0.618	0.680
Year	0.595	0.675	0.724	0.518	0.639

DAILY MARCH OF TEMPERATURE AND RELATIVE HUMIDITY.

I have computed the equations for the daily march of the temperature and the relative humidity for the extreme seasons, for the dry season, the rainy season, and for the year. In the following table these equations are grouped together. (See Tables 10, 11, and 12.)

Daily march of temperature.—In Ancon, Culebra, Colon, and Alhajuela [6] the temperature maximum occurs later in the dry season than it does in the rainy season, and the amplitudes are almost twice as great in the dry season as they are in the rainy season. Colon, however, is an exception to the latter rule, as its daily temperature range during its rainy season (October–November) is greater than during its dry season. The reason for this condition is to be sought in the wind conditions, which we have described above. The dry season has strong northerly sea winds (the trades), while the rainy season has southerly land winds. In Colon also, however, the rainy season has a lower average temperature than the dry season.

[6] Hann, Julius. Der tägliche Gang der Temperatur in den Tropen. I.—Das innere Tropengebiet. Denkschr., Kaiserl. Akad. d. Wissensch., Wien, Mathem.-naturw. Kl., 1905, 78: 284, 337.

TABLE 10.—*Daily march of temperature and humidity.*

ANCON (lat., 8° 57′ N.; long., 79° 33′ W.; alt., 28 m.)

(Departures from daily mean.)

Hours.	Dry season.		Rainy season.		Year.	
	Temperature.	Relative humidity.	Temperature.	Relative humidity.	Temperature.	Relative humidity.
	°C.	Per cent.	°C.	Per cent.	°C.	Per cent.
Midnight	−3.3	13	−1.8	7	−2.4	9.3
2 a.	−3.6	16	−2.2	7	−2.8	10.4
4 a.	−4.1	17	−2.4	8	−3.2	10.8
6 a.	*−4.3*	17	*−2.8*	7	*−3.4*	11.1
8 a.	−1.3	13	−0.1	5	−0.7	7.9
10 a.	3.0	− 3	2.8	− 5	2.7	− 3.8
Noon	5.2	−19	3.9	−13	4.3	−14.9
2 p.	5.7	*−23*	3.1	*−14*	4.2	*−17.0*
4 p.	4.9	−23	1.8	−10	3.0	−14.7
6 p.	1.6	−17	0.2	− 4	0.9	− 8.6
8 p.	−1.3	− 4	−0.8	3	−1.0	0.3
10 p.	−2.5	9	−1.4	6	−1.9	7.1
Mean	3.4	14	1.9	7	2.5	9.7
Amplitude	9.9	40	6.7	21	7.7	28.1

EQUATIONS OF THE DIURNAL CURVES.

Dry season.

Temperature, $26.2+5.02 \sin (238.3°+x)+1.33 \sin (57.3°+2x)$.
Relative humidity, $73.5+20.6 \sin (42.1°+x)+5.2 \sin (205.9°+2x)$.

Rainy season.

Temperature, $25.0+2.76 \sin (242.6°+x)+1.10 \sin (91.6°+2x)$.
Relative humidity, $87.5+10.7 \sin (59.4°+x)+3.7 \sin (231.2°+2x)$.

Year.

Temperature, $25.8+3.77 \sin (242.0°+x)+1.10 \sin (76.2°+2x)$.
Relative humidity, $82.0+14.5 \sin (49.5°+x)+3.8 \sin (233.6°+2x)$.

TABLE 11.—*Daily march of temperature and humidity.*

CULEBRA (lat., 9° 3′ N.; long., 79° 39′ W.; alt., 123 m.)

(Departures from daily mean.)

Hours.	Dry season.		Rainy season.		Year.	
	Temperature.	Relative humidity.	Temperature.	Relative humidity.	Temperature.	Relative humidity.
	°C.	Per cent.	°C.	Per cent.	°C.	Per cent.
Midnight	−2.7	14	−1.5	6	−1.9	9.4
2 a.	−3.1	15	−1.8	7	−2.3	10.3
4 a.	−3.5	17	−2.0	7	−2.6	10.7
6 a.	*−3.8*	17	*−2.2*	7	*−2.8*	11.0
8 a.	−1.4	13	−0.5	5	−1.0	8.7
10 a.	2.6	− 2	2.3	− 3	2.5	− 2.5
Noon	4.4	−18	3.6	−13	4.0	−15.2
2 p.	4.9	−23	2.7	*−14*	3.5	*−18.0*
4 p.	3.7	−22	1.3	− 8	2.4	−14.1
6 p.	1.4	−17	0.1	− 2	0.7	− 7.9
8 p.	−1.0	− 1	−0.9	3	−0.9	1.2
10 p.	−2.0	10	−1.1	6	−1.5	7.3
Mean	2.9	14	1.7	7	2.2	9.7
Amplitude	8.7	40	5.8	21	6.8	29.0

EQUATIONS OF THE DIURNAL CURVES.

Dry season.

Temperature, $25.0+4.71 \sin (229.8°+x)+1.15 \sin (62.4°+2x)$.
Relative humidity, $76.0+13.0 \sin (59.5°+x)+4.9 \sin (194.7°+2x)$.

Rainy season.

Temperature, $24.4+2.50 \sin (247.4°+x)+1.12 \sin (93.6°+2x)$.
Relative humidity, $89.3+9.1 \sin (70.8°+x)+4.0 \sin (226.8°+2x)$.

Year.

Temperature, $24.0+3.18 \sin (242.5°+x)+1.10 \sin (75.2°+2x)$.
Relative humidity, $84.0+14.4 \sin (49.5°+x)+4.4 \sin (211.4°+2x)$.

TABLE 12.—*Daily march of temperature and humidity.*

COLON (lat., 9° 22′ N.; long., 79° 54′ W.; alt., 3 m.)

(Departures from daily mean.)

Hours.	Dry season.		Rainy season.		Year.	
	Temperature.	Relative humidity.	Temperature.	Relative humidity.	Temperature.	Relative humidity.
	°C.	Per cent.	°C.	Per cent.	°C.	Per cent.
Midnight	−0.6	2.0	−1.1	3.0	−0.7	2.7
2ª	−0.9	2.5	−1.5	4.5	−1.2	3.5
4ª	−1.2	3.5	−1.7	4.5	−1.4	4.0
6ª	*−1.3*	3.5	*−1.9*	4.5	*−1.6*	4.1
8ª	−0.5	3.0	−0.4	3.0	−0.6	3.3
10ª	0.7	−0.5	1.5	− 3.0	1.0	−1.1
Noon	1.4	−4.0	2.1	− 7.5	1.7	−5.1
2ᵖ	1.5	*−5.0*	2.0	− 6.5	1.6	*−5.8*
4ᵖ	1.3	−4.5	1.3	− 4.5	1.3	−4.3
6ᵖ	0.3	−2.5	0.6	− 1.5	0.4	−2.2
8ᵖ	−0.2	0.5	0.0	0.5	−0.1	0.3
10ᵖ	−0.4	2.0	0.0	2.5	−0.4	1.8
Mean	0.8	2.8	1.2	3.8	1.0	3.2
Amplitude	2.8	8.5	4.0	12.0	3.3	9.9

EQUATIONS OF THE DIURNAL CURVES.

Dry season.

Temperature, $26.4+1.10 \sin (248.6°+x)+0.46 \sin (69.6°+2x)$.
Relative humidity, $78.5+4.3 \sin (46.1°+x)+1.4 \sin (213.1°+2x)$.

Rainy season.

Temperature, $25.6+1.85 \sin (236.6°+x)+0.57 \sin (96.1°+2x)$.
Relative humidity, $83.0+5.6 \sin (56.3°+x)+2.0 \sin (252.4°+2x)$.

Year.

Temperature, $26.2+1.50 \sin (232.3°+x)+0.52 \sin (83.4°+2x)$.
Relative humidity, $84.0+4.7 \sin (47.6°+x)+1.5 \sin (228.2°+2x)$.

There is a great difference in the rainfalls, but the influence of the prevailing winds is dominant in Colon, a fact that is particularly striking in the case of the mean ordinates of the daily temperature curves.

TABLE 13.—*Illustrating influence of prevailing winds upon rainfalls and temperatures.*

	Ancon.	Culebra.	Alhajuela.	Colon.
Mean rainfalls (millimeters):				
February–March	42	31	37	79
October–November	467	605	705	918
Mean ordinates of temperature curves:				
February–March	3.4	2.9	3.2	0.8
October–November	1.9	1.7	1.8	1.2
Year	2.5	2.2	2.3	1.0

In spite of the extraordinary quantities of the rainfall during October and November (92 cm. as compared to only 8 cm. for February and March), the daily range of temperature at Colon for those months is greater by half than it is during the dry season.

TABLE 14.—*Differences between daily temperature marches in dry season versus rainy season (dry—rainy).*

	Midnight.	2ª.	4ª.	6ª.	8ª.	10ª.	Noon.	2ᵖ.	4ᵖ.	6ᵖ.	8ᵖ.	10ᵖ.
Ancon	−1.5	−1.4	*−1.7*	−1.4	−1.2	0.2	1.3	2.6	3.1	1.4	−0.5	−1.1
Culebra	−1.2	−1.3	−1.4	*−1.6*	−0.9	0.3	0.9	2.2	2.4	1.3	−0.1	−0.9
Colon	0.5	0.6	0.6	0.6	−0.1	*−0.8*	−0.7	−0.5	0.0	−0.3	−0.2	0.2

The night hours are at least relatively cooler and the daytime hours relatively warmer during the dry season; the maximum positive temperature difference does not occur until 4ʰ p. m. This is true for Ancon and Culebra, but it is different at Colon, where the march of the considerably smaller differences is just the reverse.

Daily march of relative humidity.—The daily march of the relative humidity is just the reverse of that of the temperature, as is shown with special clearness by the equations of the daily march. The phase-angle A_1 as well the less regular A_2 for the relative humidity, differs by about 180° from those for the temperature. The minimum relative humidity occurs with the maximum temperature, and conversely the maximum humidity occurs at the time of the minimum temperature. The daily amplitude of the relative humidity is, except at Colon, three times as great in the dry season as it is in the rainy season. The minimum occurs about an hour earlier during the rainy season than it does during the dry season (dry season about 50°, rainy season about 65°); while at Colon the difference between the two seasons is somewhat smaller (46° as against 56°).

The relation between temperature amplitude and relative humidity amplitude is quite constant. If we designate the daily amplitude of the relative humidity by aF, and the daily amplitude of the temperature by at, their comparison gives the following quotients:

TABLE 15.—*Ratio of daily amplitudes of relative humidity and temperature.*

Station.	a_1F: a_1t.			a_2F: a_2t.		
	Dry.	Rainy.	Year.	Dry.	Rainy.	Year.
Ancon	4.1	3.8	3.8	3.9	3.4	3.5
Culebra	3.8	3.6	4.5	4.1	3.6	4.0
Colon	4.3	3.0	3.1	3.0	2.9	3.0
Mean	4.1	3.5	3.8	3.7	3.3	3.5

Taking the average diurnal variation in the relative humidity as a whole, a periodic temperature change of +1° C. corresponds to a change of −3.8 per cent in the relative humidity; in the average semidiurnal variation a periodic temperature change of +1.0°C. corresponds to a change of −3.5°C. in the relative humidity, or almost the same amount. One may say, then, that in their daily marches a temperature change of +10°C. corresponds to a change of about −36 per cent in the relative humidity. This relation between temperature change and humidity change is a strikingly constant one. It is but little less marked during the rainy season than during the dry season, and Colon also is no exception in this case.

TABLE 16.—*Daily march of pressure at Alhajuela, Canal Zone, 1900–1904.**

(Departures from the monthly means.)

Hour.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.	Hour.
A. M.	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	A. M.
1	0.51	0.70	0.85	0.62	0.35	0.56	0.59	0.56	0.57	0.46	0.35	0.57	0.557	1.
2	0.34	0.50	0.63	0.40	0.13	0.33	0.32	0.29	0.26	0.20	0.08	0.36	0.320	2.
3	*0.19*	*0.37*	0.46	0.21	*0.03*	0.19	0.17	0.14	*0.11*	*0.04*	*−0.08*	*0.19*	*0.168*	3.
4	0.21	0.37	*0.39*	*0.24*	0.06	*0.16*	*0.08*	*0.12*	0.15	0.11	0.00	0.21	0.175	4.
5	0.37	0.53	0.53	0.36	0.20	0.31	0.18	0.30	0.31	0.27	0.18	0.40	0.328	5.
6	0.66	0.80	0.83	0.64	0.53	0.56	0.37	0.55	0.62	0.60	0.49	0.66	0.609	6.
7	1.02	1.16	1.16	0.95	0.81	0.85	0.71	0.82	0.91	0.91	0.87	0.97	0.928	7.
8	**1.16**	**1.35**	**1.39**	1.15	**0.88**	**0.91**	**0.82**	**0.98**	**1.18**	1.10	1.08	**1.16**	**1.097**	8.
9	0.99	1.19	1.27	**1.21**	0.78	0.76	0.73	0.81	1.12	1.07	**1.09**	1.00	1.002	9.
10	0.57	0.83	0.90	0.67	0.52	0.40	0.49	0.45	0.71	0.70	0.52	0.61	0.614	10.
11	0.06	0.24	0.31	0.26	0.14	−0.12	0.07	−0.03	0.09	0.27	0.09	0.07	0.121	11.
Noon	−0.46	−0.41	−0.28	−0.19	−0.27	−0.50	−0.31	−0.52	−0.53	−0.54	−0.50	−0.47	−0.415	Noon.
P. M.														P. M.
1	−1.01	−0.88	−0.90	−0.73	−0.72	−0.86	−0.74	−0.94	−1.08	−1.05	−0.99	−1.02	−0.910	1.
2	−1.49	−1.49	*−1.55*	*−1.29*	*−1.07*	−1.14	−1.11	−1.28	*−1.52*	*−1.42*	−1.39	−1.48	−1.352	2.
3	*−1.67*	−1.90	−1.99	−1.61	−1.30	−1.36	−1.34	−1.47	*−1.71*	*−1.63*	*−1.52*	*−1.67*	*−1.597*	3.
4	−1.64	*−1.96*	*−2.09*	*−1.75*	*−1.53*	*−1.37*	*−1.38*	*−1.60*	−1.59	−1.53	−1.42	−1.60	*−1.596*	4.
5	−1.36	−1.76	−1.94	−1.63	−1.17	−1.18	−1.24	−1.25	−1.35	−1.26	−1.17	−1.40	−1.392	5.
6	−0.90	−1.24	−1.51	−1.25	−0.77	−0.80	−0.88	−0.83	−0.89	−0.87	−0.71	−0.90	−0.962	6.
7	−0.39	−0.73	−0.92	−0.68	−0.33	−0.32	−0.40	−0.35	−0.41	−0.38	−0.23	−0.42	−0.463	7.
8	0.13	−0.20	−0.31	−0.18	0.10	0.08	0.07	0.13	0.07	0.11	0.22	0.11	0.027	8.
9	0.51	0.28	0.15	0.28	0.42	0.42	0.47	0.48	0.50	0.51	0.65	0.48	0.429	9.
10	0.77	0.65	0.67	0.62	0.64	0.65	0.75	0.81	0.77	0.74	**0.84**	0.71	0.718	10.
11	**0.82**	**0.85**	0.94	**0.82**	**0.73**	**0.76**	**0.86**	**0.86**	**0.89**	**0.83**	0.80	**0.78**	**0.828**	11.
12	−0.73	0.85	**1.01**	0.79	0.58	0.75	0.83	0.79	0.75	0.68	0.64	0.71	0.759	12.
Mean	0.748	0.885	0.957	0.772	0.577	0.639	0.621	0.677	0.754	0.720	0.663	0.748	0.724	Mean.
Monthly mean.	759.75	759.72	759.41	758.78	759.51	759.33	759.65	759.69	759.98	760.03	759.82	759.55	759.60	Monthly mean.

* See the opening paragraphs of this paper and footnote 2.

TABLE 17.—*Daily march of pressure at Ancon, Canal Zone.*

(Departures from the monthly means.)

Hour.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.	Hour.
	Mm.	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	
Midnight	0.63	0.61	0.63	0.58	0.32	0.50	0.46	0.54	0.48	0.42	0.37	0.40	0.495	Midnight.
2ª	−0.14	0.00	0.04	−0.06	−0.27	−0.19	−0.05	−0.14	−0.20	−0.39	−0.39	−0.26	−0.171	2ª.
4ª	−0.21	−0.20	−0.08	−0.19	−0.39	−0.36	−0.25	−0.27	−0.46	−0.47	−0.56	−0.41	−0.321	4ª.
6ª	0.17	0.24	0.33	0.32	0.06	0.01	0.02	0.08	0.10	0.11	0.07	0.15	0.138	6ª.
8ª	1.06	1.07	1.09	0.98	0.88	0.71	0.64	0.74	0.93	1.01	1.01	1.11	0.936	8ª.
10ª	1.13	1.25	1.21	1.08	1.00	0.83	0.77	0.93	1.12	1.18	1.27	1.11	1.073	10ª.
Noon	0.22	0.36	0.19	0.35	0.37	0.32	0.21	0.37	0.42	0.29	0.25	0.20	0.296	Noon.
2P	−1.10	−0.96	−1.15	−1.00	−0.57	−0.41	−0.55	−0.65	−0.74	−0.90	−0.90	−0.97	−0.825	2P.
4P	−1.53	−1.52	−1.71	−1.63	−1.21	−1.12	−1.11	−1.24	−1.25	−1.36	−1.27	−1.32	−1.356	4P.
6P	−0.97	−1.08	−1.20	−1.07	−0.83	−0.77	−0.74	−0.90	−0.92	−0.77	−0.77	−0.77	−0.899	6P.
8P	0.12	−0.12	−0.08	−0.11	0.06	−0.01	0.00	−0.09	−0.08	0.16	0.20	0.10	0.012	8P.
10P	0.63	0.39	0.68	0.71	0.57	0.52	0.59	0.62	0.61	0.67	0.76	0.71	0.622	10P.
Mean	0.659	0.650	0.699	0.673	0.544	0.479	0.449	0.547	0.609	0.644	0.652	0.626	0.595	Mean.

TABLE 18.—*Daily march of pressure at Culebra, Canal Zone.*

(Departures from monthly means.)

Hour.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.	Hour.
	Mm.	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	
Midnight	0.77	0.76	0.85	0.84	0.68	0.73	0.80	0.80	0.73	0.57	0.71	0.65	0.741	Midnight.
2ª	0.11	0.25	0.29	0.28	0.10	0.32	0.29	0.24	0.14	0.11	−0.10	0.09	0.177	2ª.
4ª	−0.14	−0.10	0.03	−0.07	−0.08	−0.14	−0.06	−0.22	−0.28	−0.32	−0.30	−0.29	−0.164	4ª.
6ª	0.21	0.20	0.44	0.23	0.07	0.17	0.04	0.04	0.07	0.06	0.07	0.09	0.141	6ª.
8ª	1.13	1.11	1.05	1.20	0.73	0.73	0.65	0.60	0.79	1.00	0.97	1.03	0.916	8ª.
10ª	1.38	1.42	1.36	1.25	0.98	0.98	0.75	1.00	1.09	1.25	1.27	1.41	1.178	10ª.
Noon	0.21	0.25	0.19	0.18	0.30	0.27	0.09	0.34	0.43	0.19	0.20	0.09	0.228	Noon.
2P	−1.16	−1.17	−1.24	−1.09	−0.84	−0.74	−0.82	−0.83	−0.84	−1.03	−1.07	−1.26	−1.007	2P.
4P	−1.82	−1.88	−2.05	−1.85	−1.43	−1.34	−1.39	−1.44	−1.50	−1.54	−1.57	−1.77	−1.632	4P.
6P	−1.37	−1.48	−1.64	−1.65	−1.22	−1.10	−1.08	−1.08	−1.20	−0.96	−1.07	−1.06	−1.243	6P.
8P	0.11	−0.05	−0.02	−0.02	0.17	−0.39	0.09	−0.12	−0.08	0.06	0.20	0.21	0.013	8P.
10P	0.62	0.66	0.69	0.70	0.56	0.58	0.70	0.70	0.63	0.57	0.71	0.77	0.657	10P.
Mean	0.752	0.777	0.821	0.780	0.597	0.624	0.563	0.617	0.648	0.638	0.687	0.727	0.675	Mean.

TABLE 19.—*Daily march of pressure at Colon, Canal Zone.*

(Departures from monthly means.)

Hour.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.	Hour.
	Mm.	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	
Midnight	0.52	0.46	0.57	0.58	0.55	0.58	0.58	0.57	0.59	0.56	0.55	0.48	0.549	Midnight.
2a	−0.14	0.20	0.13	0.19	0.35	0.20	0.18	0.21	0.26	0.15	0.04	0.05	0.152	2a.
4a	−0.26	−0.13	−0.20	−0.16	−0.03	0.07	0.00	−0.04	−0.05	−0.17	−0.20	−0.26	−0.119	4a.
6a	−0.06	−0.10	−0.07	−0.03	0.05	0.07	−0.13	−0.09	0.03	0.05	0.04	−0.08	−0.027	6a.
8a	0.65	0.63	0.69	0.70	0.68	0.63	0.50	0.60	0.80	0.86	0.88	0.81	0.702	8a.
10a	1.03	1.01	0.99	0.96	0.81	0.50	0.68	0.75	0.97	1.11	1.06	1.01	0.907	10a.
Noon	0.45	0.53	0.52	0.48	0.18	0.25	0.25	0.20	0.34	0.20	0.12	0.35	0.330	Noon.
2p	−0.57	−0.44	−0.50	−0.54	−0.72	−0.64	−0.51	−0.60	−0.81	−0.97	−0.97	−0.71	−0.665	2p.
4p	−1.08	−1.12	−1.16	−1.25	−1.30	−1.13	−1.07	−1.21	−1.39	−1.48	−1.36	−1.22	−1.231	4p.
6p	−1.03	−1.20	−1.16	−1.13	−0.97	−0.94	−0.89	−1.03	−1.19	−0.97	−0.97	−0.97	−1.037	6p.
8p	0.01	−0.24	−0.20	−0.18	−0.03	0.02	0.08	−0.04	−0.05	0.10	0.17	0.00	−0.030	8p.
10p	0.52	0.41	0.38	0.34	0.43	0.40	0.38	0.55	0.51	0.60	0.63	0.48	0.470	10p.
Mean	0.527	0.539	0.547	0.545	0.508	0.452	0.437	0.498	0.582	0.602	0.583	0.618	0.518	Mean.

TABLE 20.—*Daily march of temperature at Ancon, Canal Zone.*

(Departure from monthly means.)

Hour.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.	Hour.
	°*C.*	°*C.*	°*C.*	°*C.*	°*C.*	°*C.*	°*C.*	°*C.*	°*C.*	°*C.*	°*C.*	°*C.*	°*C.*	
2a	−3.3	−3.6	−3.7	−3.4	−2.5	−2.3	−2.5	−2.6	−2.5	−2.0	−2.3	−2.9	−2.8	2a.
4a	−3.6	−3.8	−4.3	−3.7	−3.0	−2.6	−2.7	−2.9	−2.9	−2.4	−2.4	−3.2	−3.2	4a.
6a	−3.9	−4.1	−4.3	−3.8	−3.3	−2.6	−3.0	−3.1	−3.0	−2.9	−2.7	−3.5	−3.4	6a.
8a	−1.5	−1.6	−1.2	−0.5	−0.1	−0.4	−0.4	−0.4	−0.5	−0.1	−0.1	−1.1	−0.7	8a.
10a	3.0	3.0	3.0	3.0	3.0	2.4	2.4	2.5	2.4	2.9	2.7	2.8	2.7	10a.
Noon	5.1	5.0	5.4	4.7	3.8	3.5	3.8	3.9	3.6	4.0	3.8	4.8	4.3	Noon.
2p	5.5	5.6	5.9	4.7	3.3	3.3	3.5	3.5	3.5	3.0	3.2	4.3	4.1	2p.
4p	4.5	4.8	5.0	3.7	2.3	2.1	2.4	2.4	2.4	1.7	2.0	3.5	3.0	4p.
6p	1.2	1.5	1.8	1.3	0.8	0.6	0.7	0.7	0.8	0.2	0.2	0.8	0.9	6p.
8p	−1.4	−1.3	−1.4	−1.2	−0.8	−0.5	−0.7	−0.9	−0.7	−0.8	−0.9	−1.2	−1.0	8p.
10p	−2.4	−2.5	−2.5	−2.3	−1.6	−1.4	−1.6	−1.5	−1.5	−1.5	−1.3	−2.1	−1.9	10p.
12p	−3.0	−3.2	−3.3	−2.8	−2.2	−1.9	−2.1	−2.1	−2.0	−1.8	−1.7	−2.4	−2.4	12p.
Means	3.20	3.33	3.48	2.92	2.22	1.97	2.15	2.21	2.15	1.94	1.94	2.72	2.53	Mean.

TABLE 21.—*Daily march of temperature at Culebra, Canal Zone.*

(Departure from monthly means.)

Hour.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.	Hour.
	°*C.*	°*C.*	°*C.*	°*C.*	°*C.*	°*C.*	°*C.*	°*C.*	°*C.*	°*C.*	°*C.*	°*C.*	°*C.*	
2a	−2.6	−2.9	−3.3	−3.0	−2.4	−1.5	−2.1	−2.0	−2.1	−2.0	−1.6	−2.1	−2.3	2a.
4a	−3.2	−3.2	−3.6	−3.4	−2.4	−2.4	−2.2	−2.2	−2.2	−2.2	−1.9	−2.5	−2.6	4a.
6a	−3.2	−3.6	−3.9	−3.6	−2.8	−2.6	−2.2	−2.4	−2.5	−2.3	−2.1	−2.7	−2.8	6a.
8a	−1.7	−1.7	−1.2	−0.5	−0.6	−1.0	−0.9	−0.8	−0.6	−0.5	−0.5	−1.8	−1.0	8a.
10a	2.4	2.3	2.9	3.0	3.3	2.1	2.1	2.2	2.7	2.4	2.2	2.3	2.5	10a.
Noon	4.1	4.3	4.7	4.5	4.0	3.7	3.8	3.8	3.9	3.7	3.4	4.0	4.0	Noon.
2p	4.4	4.8	5.0	4.3	3.0	3.1	3.0	3.2	3.3	2.8	2.6	3.7	3.5	2p.
4p	3.6	3.5	3.9	3.1	1.6	1.7	1.9	1.8	1.7	1.3	1.4	2.7	2.4	4p.
6p	1.3	1.4	1.4	1.0	0.4	0.4	0.7	0.6	0.4	0.1	0.1	0.8	0.7	6p.
8p	0.9	−1.0	−1.0	−1.1	−1.0	−1.0	−0.9	−0.8	−0.9	−0.9	−0.9	−0.9	−0.9	8p.
10p	−1.8	−1.9	−2.1	−1.8	−1.6	−1.4	−1.3	−1.3	−1.5	−1.2	−1.1	−1.5	−1.5	10p.
12p	−2.5	−2.5	−2.8	−2.1	−1.7	−1.5	−1.5	−1.7	−1.7	−1.6	−1.3	−1.8	−1.9	12p.
Mean	2.64	2.76	2.98	2.62	2.07	1.87	1.88	1.90	1.96	1.75	1.59	2.22	2.17	Mean.

TABLE 22.—*Daily march of temperature at Colon, Canal Zone.*

(Departure from monthly means.)

Hour.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.	Hour.
	°*C.*	°*C.*	°*C.*	°*C.*	°*C.*	°*C.*	°*C.*	°*C.*	°*C.*	°*C.*	°*C.*	°*C.*	°*C.*	
2a	−0.9	−0.8	−1.0	−1.2	−1.1	−1.4	−1.0	−1.2	−1.4	−1.6	−1.4	−0.9	−1.2	2a.
4a	−1.2	−1.1	−1.2	−1.3	−1.4	−1.8	−1.6	−1.3	−1.7	−1.9	−1.5	−1.2	−1.4	4a.
6a	−1.2	−1.2	−1.4	−1.3	−1.8	−2.0	−1.6	−1.9	−2.0	−2.1	−1.7	−1.5	−1.6	6a.
8a	−0.6	−0.5	−0.6	−0.5	−0.6	−0.6	−0.6	−0.9	−0.6	−0.3	−0.6	−0.5	−0.6	8a.
10a	0.8	0.6	0.8	0.9	1.1	1.1	0.9	0.9	1.5	1.8	1.2	0.7	1.0	10a.
Noon	1.4	1.4	1.5	1.6	2.0	2.0	1.7	1.6	2.2	2.5	1.6	1.5	1.7	Noon.
2p	1.6	1.4	1.5	1.5	1.7	1.7	1.5	1.4	1.9	2.2	1.8	1.6	1.6	2p.
4p	1.2	1.3	1.3	1.3	1.4	1.2	1.1	1.1	1.5	1.4	1.2	1.1	1.3	4p.
6p	0.1	0.4	0.2	0.4	0.4	0.7	0.5	0.6	0.6	0.6	0.5	0.3	0.4	6p.
8p	−0.1	−0.2	−0.3	−0.1	−0.2	0.1	0.0	1.1	0.0	−0.2	0.2	0.1	−0.1	8p.
10p	−0.5	−0.2	−0.6	−0.5	−0.6	−0.4	−0.2	−0.3	−0.5	−0.8	−0.3	−0.2	−0.4	10p.
12p	−0.6	−0.5	−0.7	−0.6	−0.7	−0.8	−0.5	−0.6	−0.9	−1.2	−0.9	−0.5	−0.7	12p.
Mean	0.85	0.80	0.92	0.93	1.08	1.15	0.93	0.99	1.23	1.38	1.07	0.84	1.00	Mean.

TABLE 23.—*Daily march of relative humidity at Ancon, Canal Zone.*

(Departures from monthly means.)

Hours.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
2a	14	15	16	13	9	8	8	9	8	7	7	11	10.4
4a	15	16	17	14	10	8	8	9	8	7	7	11	10.8
6a	15	16	18	15	10	8	9	9	8	7	7	11	11.1
8a	12	13	14	9	6	5	6	6	5	5	5	9	7.9
10a	− 3	− 3	− 3	− 6	− 5	− 3	− 4	− 3	− 4	− 5	− 4	− 3	− 3.8
Noon	−18	−19	−19	−16	−13	−11	−13	−13	−13	−14	−13	−17	−14.9
2p	−23	−23	−24	−19	−13	−12	−15	−15	−14	−14	−14	−18	−17.0
4p	−22	−22	−24	−18	−10	− 9	−12	−12	−12	−10	−10	−16	−14.7
6p	−15	−16	−18	−13	− 5	− 5	− 6	− 6	− 2	− 4	− 4	− 9	− 8.6
8p	0	− 3	− 4	− 2	1	1	1	1	1	3	3	1	0.3
10p	9	9	9	7	6	6	6	7	5	7	6	8	7.1
12p	13	13	14	11	8	7	7	8	7	7	7	10	9.3
Mean	13	14	15	12	8	7	8	8	7	7	7	10	9.7

TABLE 24.—*Daily march of relative humidity at Culebra, Canal Zone.*

(Departures from monthly means.)

Hours.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
2a	13	14	17	15	9	8	9	8	8	7	7	9	10.3
4a	14	15	18	15	10	8	9	8	8	7	7	10	10.7
6a	14	16	18	16	10	8	9	8	8	7	7	10	11.0
8a	13	13	14	11	7	7	7	6	5	5	5	8	8.7
10a	− 1	− 1	− 3	− 5	− 4	− 1	− 2	− 2	− 4	− 4	− 3	− 1	− 2.5
Noon	−16	−17	−19	−18	−16	−13	−13	−14	−14	−15	−12	−15	−15.2
2p	−21	−23	−24	−21	−16	−16	−16	−17	−16	−15	−12	−19	−18.0
4p	−21	−21	−22	−18	−10	−11	−11	−11	−11	− 9	− 8	−16	−14.1
6p	−14	−15	−18	−12	− 4	− 5	− 5	− 4	− 5	− 2	− 2	− 9	− 7.9
8p	0	− 1	− 2	0	3	2	− 1	2	3	3	4	2	1.2
10p	9	8	11	9	7	6	7	6	6	6	6	7	7.3
12p	12	13	14	13	9	7	8	8	7	7	6	9	9.4
Mean	12	13	15	13	9	8	8	8	8	7	7	10	9.7

TABLE 25.—*Daily march of relative humidity at Colon, Canal Zone.*

(Departures from monthly means.)

Hours.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug	Sept.	Oct.	Nov.	Dec.	Year.
2a	3	2	3	3	3	4	3	4	5	5	4	3	3.5
4a	3	3	4	4	4	5	4	4	5	5	4	3	4.0
6a	4	3	4	4	4	5	4	4	5	5	4	3	4.1
8a	3	3	4	3	3	4	3	4	4	3	3	3	3.3
10a	0	0	− 1	− 1	− 1	0	− 1	− 1	− 2	− 4	− 2	0	− 1.1
Noon	− 4	− 4	− 4	− 5	− 4	− 6	− 4	− 5	− 7	−10	− 5	− 3	− 5.1
2p	− 5	− 5	− 5	− 5	− 4	− 7	− 6	− 5	−10	− 8	− 5	− 5	− 5.8
4p	− 5	− 5	− 4	− 5	− 3	− 5	− 4	− 3	− 5	− 5	− 4	− 4	− 4.3
6p	− 2	− 3	− 2	− 3	− 2	− 3	− 2	− 2	− 3	− 2	− 1	− 2	− 2.2
8p	1	0	1	0	1	0	0	0	1	1	0	0	0.3
10p	2	1	3	2	2	1	1	2	2	3	2	1	1.8
12p	2	2	3	2	3	3	3	3	4	3	3	2	2.7
Mean	3	3	3	3	3	4	3	3	4	4	3	2	3.2

TABLE 26.—*Average hourly temperature at Ancon, Canal Zone.*

Hours.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
	°C.	°C.	°C.	°C.	°C.	°C.	°C.	°C.	°C.	°C.	°C.	°C.	°C.
2a	22.4	22.3	22.7	23.2	23.4	23.5	23.3	23.2	23.3	23.2	22.6	22.6	23.0
4a	22.1	22.1	22.1	22.9	23.2	23.2	23.1	22.9	22.9	22.8	22.5	22.3	22.6
6a	*21.8*	*21.8*	*22.1*	*22.8*	*22.6*	*23.2*	*22.8*	*22.7*	*22.8*	*22.5*	*22.2*	*22.0*	*22.4*
8a	24.2	24.3	25.2	26.1	25.8	25.4	25.4	25.4	25.3	25.1	24.8	24.4	25.1
10a	28.7	28.9	29.4	29.6	28.9	28.2	28.2	28.3	28.2	28.1	27.6	28.3	28.5
Noon	30.8	30.9	31.8	31.3	29.7	**29.3**	**29.6**	**29.7**	**29.4**	**29.2**	**28.7**	**30.3**	**30.1**
2p	**31.2**	**31.5**	**32.3**	**31.3**	**29.2**	29.1	29.3	29.3	29.3	28.2	28.1	29.8	29.9
4p	30.2	30.7	31.4	30.3	28.2	27.9	28.2	28.2	28.2	26.9	26.9	29.0	28.8
6p	26.9	27.4	28.2	27.9	26.7	26.4	26.5	26.6	25.4	25.1	26.3	26.3	26.7
8p	24.3	24.6	25.0	25.4	25.1	25.3	25.1	24.9	25.1	24.4	24.0	24.3	24.8
10p	23.3	23.4	23.9	24.3	24.4	24.2	24.3	24.3	24.3	23.7	23.6	23.4	23.9
12p	22.7	22.7	23.1	23.8	23.7	23.9	23.7	23.7	23.8	23.4	23.2	23.1	23.4
Mean	25.7	25.9	26.4	26.6	25.9	25.8	25.8	25.8	25.8	25.2	24.9	25.5	25.8

TABLE 27.—*Average hourly temperature at Culebra, Canal Zone.*

Hours.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
	°C.	°C.	°C.	°C.	°C.	°C.	°C.	°C.	°C.	°C.	°C.	°C.	°C.
2a	22.0	21.9	21.9	22.7	22.9	23.7	23.0	23.0	22.8	22.5	22.6	22.5	22.6
4a	21.4	21.6	21.6	22.3	22.9	22.8	22.9	22.8	22.7	22.3	22.3	22.1	22.3
6a	*21.4*	*21.2*	*21.3*	*22.1*	*22.5*	*22.6*	*22.9*	*22.6*	*22.4*	*22.3*	*22.1*	*21.9*	*22.1*
8a	22.9	23.1	24.0	25.2	24.7	24.2	24.2	24.2	24.3	24.0	23.7	22.8	23.9
10a	27.0	27.1	28.1	28.7	28.6	27.3	27.2	27.2	27.6	26.9	26.4	26.8	27.4
Noon	28.7	29.1	29.9	**30.2**	**29.3**	**28.9**	**28.9**	**28.8**	**28.8**	**28.2**	**27.6**	**28.6**	**28.9**
2p	**29.0**	**29.6**	**30.2**	30.0	28.3	28.3	28.1	28.2	28.2	27.3	26.8	28.3	28.4
4p	28.2	28.3	29.1	28.8	26.9	26.9	27.0	26.8	26.6	25.8	25.6	27.3	27.3
6p	25.9	26.2	26.6	26.7	25.7	25.6	25.8	25.6	25.3	24.6	24.3	25.4	25.6
8p	23.7	23.8	24.2	24.6	24.3	24.2	24.2	24.2	24.0	23.6	23.3	23.7	24.0
10p	22.8	22.9	23.1	23.9	23.7	23.8	23.8	23.7	23.4	23.3	23.1	23.1	23.4
12p	22.1	22.3	22.4	23.6	23.6	23.7	23.6	23.3	23.2	22.9	22.9	22.8	23.0
Mean	24.6	24.8	25.2	25.7	25.3	25.2	25.1	25.0	24.9	24.5	24.2	24.6	24.9

TABLE 28.—*Average hourly temperature at Colon, Canal Zone.*

Hours.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
	°C.	°C.	°C.	°C.	°C.	°C.	°C.	°C.	°C.	°C.	°C.	°C.	°C.
2a	25.4	25.4	25.6	25.7	25.3	24.8	25.2	25.0	24.7	23.9	24.3	25.2	25.0
4a	25.1	25.1	25.4	25.6	25.0	24.4	24.6	24.9	24.4	23.6	24.2	24.9	24.8
6a	*25.1*	*25.0*	*25.3*	*25.6*	*24.6*	*24.2*	*24.6*	*24.8*	*24.1*	*23.4*	*24.0*	*24.6*	*24.6*
8a	25.7	25.7	26.0	26.4	25.8	25.6	25.6	25.3	25.5	25.2	25.1	25.6	25.6
10a	27.1	26.8	27.4	27.8	27.5	27.3	27.1	27.1	27.6	27.3	26.9	26.8	27.2
Noon	27.6	27.6	**28.1**	**28.5**	**28.4**	**28.2**	**27.9**	**27.8**	**28.3**	**28.0**	27.3	27.6	**27.9**
2p	**27.9**	**27.6**	**28.1**	28.4	28.1	27.9	27.7	27.6	28.0	27.7	**27.5**	**27.7**	27.8
4p	27.5	27.5	27.9	28.2	27.8	27.4	27.3	27.3	27.6	26.9	26.9	27.2	27.5
6p	26.4	26.6	26.8	27.3	26.8	26.9	26.7	26.8	26.7	26.1	26.2	26.4	26.6
8p	26.2	26.2	26.3	26.8	26.2	26.3	26.2	26.3	26.1	25.3	25.9	26.2	26.1
10p	25.8	26.0	26.0	26.4	25.8	25.8	26.0	25.9	25.6	24.7	25.4	25.9	25.8
12p	25.7	25.7	25.9	26.3	25.7	25.4	25.7	25.6	25.2	24.3	24.8	25.6	25.5
Mean	26.3	26.2	26.6	26.6	26.4	26.2	26.2	26.2	26.1	25.5	25.7	26.1	26.2

TABLE 29.—*Average hourly relative humidity at Ancon, Canal Zone.*

(6 years.)

Hours.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
2a	91	90	88	90	94	94	94	95	95	94	95	94	93
4a	92	91	89	91	95	94	94	95	95	94	95	94	93
6a	92	91	90	92	95	94	95	95	95	94	95	94	93
8a	89	88	86	86	91	91	92	92	92	92	93	92	90
10a	74	72	69	71	80	83	82	83	83	82	84	80	79
Noon	59	56	53	61	72	75	73	73	74	73	75	66	67
2p	54	52	48	58	72	74	71	71	73	73	74	65	65
4p	55	53	48	59	75	77	74	74	75	77	78	67	68
6p	62	59	54	64	80	81	80	80	85	83	84	74	74
8p	77	72	68	75	86	86	87	87	88	90	91	84	83
10p	86	84	81	84	91	92	92	93	92	94	94	91	89
12p	90	88	86	88	93	93	93	94	94	94	95	93	92
Mean	77	75	72	77	85	86	86	86	87	87	88	83	82

TABLE 30.—*Average hourly relative humidity at Culebra, Canal Zone.*

(4–5 years.)

Hours.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
2a	92	92	91	93	94	96	96	96	96	96	96	94	94
4a	93	93	92	93	95	96	96	96	96	96	96	95	95
6a	93	94	92	94	95	96	96	96	96	96	96	95	95
8a	93	91	88	89	92	95	94	95	94	94	94	94	93
10a	78	77	71	73	81	87	85	86	84	85	87	84	81
Noon	63	61	55	60	69	75	74	74	74	74	77	70	69
2p	*58*	*55*	*50*	*57*	*69*	*73*	*71*	*71*	*73*	*74*	*77*	*66*	*66*
4p	58	57	52	60	75	77	76	77	77	80	81	69	70
6p	65	63	56	66	81	83	82	84	83	87	87	76	76
8p	79	77	72	78	88	90	86	90	91	92	93	87	85
10p	88	86	85	87	92	94	94	94	95	95	95	92	91
12p	91	91	88	91	94	95	95	96	95	96	95	94	93
Mean	79	78	74	78	85	88	87	88	88	89	89.5	85	84

TABLE 31.—*Average hourly relative humidity at Colon, Canal Zone.*

(5–7 years.)

Hours.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
2a	83	82	80	83	88	91	90	91	92	93	92	88	88
4a	83	83	81	84	89	92	91	91	92	93	92	88	88
6a	84	83	81	84	89	92	91	91	92	93	92	88	88
8a	83	83	81	83	88	91	90	91	91	91	91	88	88
10a	80	80	76	79	84	87	86	86	85	84	86	85	83
Noon	76	76	73	75	81	81	83	82	80	78	83	82	79
2p	75	75	72	75	81	80	81	82	77	80	85	80	78
4p	75	75	73	75	82	82	83	84	82	83	84	81	80
6p	78	77	75	77	83	84	85	85	84	86	87	83	82
8p	81	80	78	80	86	87	87	87	87	89	88	85	85
10p	82	81	80	82	87	88	88	89	89	91	90	86	86
12p	83	82	80	82	88	90	90	90	91	91	91	87	87
Mean	80	80	77	80	85	87	87	87	87	88	88	85	84

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THE FUNCTION OF THE ATMOSPHERE IN [WIRELESS] TRANSMISSION.[1]

By J. ERSKINE-MURRAY, Sc. D.

[Dr. James Erskine-Murray was born in Edinburgh on October 24, 1868, and after a course of six years' study under the late Lord Kelvin at Glasgow University he entered Trinity College, Cambridge, as a research student. In 1898 he was appointed experimental assistant to Mr. Marconi. In 1900 he took up the post of lecturer and demonstrator in physics and electrical engineering at the University College, Nottingham, and in 1905 he was appointed to the lectureship in electrical engineering at the George Coates' Technical College, Paisley. In 1905 he took up consulting work in radiotelegraphy.

[The following paper is reprinted by permission of the editor of the Yearbook, Mr. Arthur Cohen.]

An interesting article by Dr. Eccles on certain aspects of transmission through the atmosphere appeared in the Yearbook [of wireless telegraphy] for 1913, the treatment of the subject being mainly from the point of view of his own and other physical theories for the explanation of "freak" transmissions. In the following pages I have attempted to analyze typical cases of unusual wireless transmission and to deduce from these in conjunction with the known and fundamental physical facts of the case a true idea of the function of the atmosphere in transmission without the use of any explanatory hypotheses.

That the atmosphere ought to have some slight influence on the transmission of electric or "ether" waves from place to place on the earth's surface is obvious when one recollects that the air, though a very good insulator at pressures such as exist at the earth's surface, is nowhere a perfect insulator and has quite different electrical qualities at the low pressures which occur at heights above 30 or 40 miles to those it possesses at lower elevations.

Electrical waves must necessarily have a good insulator to pass through; they are guided by a conductor, but do not pass through it, only diffusing slowly into it and being dissipated as heat in the conducting material. The better the conductor the smaller is the depth of penetration of the waves into it and the less the loss of energy on this account. At the same time every conductor, whether a wire or a great mass like the earth, does conduct—that is to say, the electrical disturbance follows and is guided by its surface.

In Hertz's experiments and in Mr. Marconi's earliest form of apparatus true radiation took place, i. e., there was a free and unguided passage of an electric disturbance from one conductor to another conductor through an insulating medium, the air, in which both were situated.

In modern wireless telegraphy free radiation does not take place when the stations are situated on land or sea, for the receiver is actually in direct connection with the earth and the latter forms part of the transmitter. Modern wireless is thus merely transmission from one part of a conductor to another part of the same. No return circuit such as is used in ordinary telegraphy is needed, because the disturbance is not continuous but alternating, and is of comparatively small wave length. I may quote from the 1907 edition of my handbook[2] a definition which puts the matter succinctly; it is as follows:

> Reduced to its simplest terms, the modern wireless telegraph is a large conducting sphere (the earth) with two conducting excrescences on it or near its surface (the aerial conductors). In one of these a sudden oscillatory movement of electricity is started, which spreads over the surface, causing to-and-fro currents in the other wire is it passes.

It will be understood, therefore, that as these have been my views since 1898, I was not one of those whom Dr. Eccles in his article in last year's Yearbook speaks of as being surprised at Mr. Marconi's success in trans-Atlantic transmission round the curve of the world.

If the lower atmosphere were as conductive as the sea is, wireless telegraphy from place to place on the earth's surface would be impossible, for the electric waves would not penetrate such a material to more than a few yards from the transmitter. Thus wireless telegraphy between completely submerged submarines is impracticable. The same is true in regard to wireless transmission in mines. Where the rocks are dry and insulating, transmission is possible through them up to a mile or two; but where they are wet and therefore conducting, wireless telegraphy is impracticable. The nonconducting layer of air in contact with the ground and rising to some 30 miles above it is thus the stratum through which the electric waves can pass in traveling from station to station. Above lies the less dense air which is certainly not a good insulator and therefore must either absorb or reflect the waves which come up to it from the transmitter. There is now experimental evidence that at night this upper layer does reflect the waves down again, and thus signals are received at greater distances than in the daytime; and Dr. [L. W.] Austin is of opinion that even in the daytime the action is not always absorption only, but that occasionally there is a slight strengthening of the signals by reflection.

The first suggestion of which I am aware, that indicates the importance of the upper atmosphere in the transmission of electrical waves over the earth's surface is contained in a paper which the late G. F. Fitzgerald read at the British Association Meeting in 1893. In discussing the probable period of an electrical oscillation of the earth as a whole, he remarks that—

> The period of oscillation of a simple sphere of the size of the earth, supposed charged with opposite charges of electricity at its ends, would be almost one-seventeenth of a second; but the hypothesis that the earth is a conducting body surrounded by a nonconductor is not in accordance with the fact. Probably the upper regions of our atmosphere are fairly good conductors.

He then proceeds to calculate the period of oscillation considering the earth and upper atmosphere as two concentric spherical conductors and finds that if the height of the region of the aurora, i. e., of the conducting layer, be 60 miles the period comes out at 0.1 second, while, if the height be 6 miles, the period becomes 0.3 second.

[1] *Reprinted by request from* Year Book of Wireless Telegraphy and Telephony, 1914. Marconi Press Agency (Ltd.), London, [1914]. p. 504–512.

[2] Erskine-Murray, J. Handbook of wireless telegraphy. London, 1907.